Abstract, artistic and realistic representations and interactions with Big Data

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ABSTRACT
This white paper explores abstracted, realistic and artistic approaches to the challenge of representing and interacting with Big Data. The first approach simplifies complex spatiotemporal data so that insights can be gained from static representations or through interaction with linked displays. The second approach uses virtual environments to 'experience' big data. The third approach explores the use of art as a complementary spatiotemporal representation.

Author Keywords
Spatiotemporal data, maps, virtual environments, art.

ACM Classification Keywords
H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous; I.3.m. Computer Graphics: Miscellaneous;

INTRODUCTION

Big Data is a recent phenomenon where the volume (size), velocity (rate of growth), variety (heterogeneity) exhaustivity in scope, resolution, relational qualities and flexibility of data [9] is such that computing technology does not have the capability of processing it all in an effective manner. For spatial data, they are also multidimensional (spatiotemporal), are governed by spatial and temporal scale and have embedded uncertainty [13]. There is therefore a big challenge with opportunities and risks for geography [9], GIScience and cartography. We are in a good position to develop tailored representations and interfaces that cause humans to visually discover the hidden content of big spatiotemporal data, turning them into information and then, knowledge [13].

ABSTRACTED

Cartography is good at abstraction of real world (spatiotemporal) aspects into maps, map-like and aspatial renderings. Part of the nature of big spatiotemporal data is that it cannot be effectively mapped as is and in a conventional manner (e.g. flow maps), even with representations tailored to the spatiotemporal (space time cube [11]), though attempts have been made to generalize and aggregate xyt data. The abstraction can go further, with space (xy) having less of a true representational presence, shifting visual emphasis to the object as it changes. For example, the RElative MOtion method [12] is a 2D matrix that graphs a number of objects against a number of time intervals, representing direction of motion or velocity where they intersect. A modification optimizes the order of object rows to reflect proximity of objects in space-time [17].

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Not only is this a call to continue research into spatiotemporal representation of differing degrees of abstraction, but also to explore dynamic representation e.g. in visual analytics situations. More abstract representations would benefit from a dynamic link to a map, for example.

REALISTIC

There should be renewed research into realistic (also non-realistic but immersive) 3D representations and interactions in virtual environments (VEs). The potential of VEs was perceived as high in the 2001 agenda [2, 4, 5, 13, 18], since then having a modest research presence in the ICA commissions [19]. There has been resurgence in research effort into VEs in a GIScience context (Virtual Geographic Environments - VGEs [6]), augmented by technology such as cheap high performance HMDs (e.g. Oculus Rift). These VEs tend to be more readily available and online, popularized through Second Life (SL) and the free SL emulation Open Simulator. Example 'realistic' applications include a real-time campus VE linked to a GPS in OpenSim [3] and geographic experiments in SL [7]. But there is also scope for exploring even more abstracted representations in immersive environments, for example using spatialisation [4]. An example is a spatialisation of work projects in OpenSim [15]. However, more investigation must be made into visual metaphors (in this case, landscape), matching them to data [5] and humans [2].

The need for cartographic theory to be adapted for immersive environments was stressed in the 2001 agenda [13]: "…like a map, [VR] representations are still based in abstraction and design" [4, p.9]. Although there has been investigation into use of graphical variables in a VGE context [14], research into cartographic symbology in 3D contexts has still received little attention [10].

Beyond a dynamic 3D representation, the main benefit that VGE can bring to the challenge of big data is experiential: "whether the representation used in a virtual environment is realistic or abstract, the interpretive load put on the user may be minimized by providing realistic interaction with a representation" [4, p.9]. It can also be a tool for naturalistic collaboration [highlighted in 2, 5] but appropriate interface tools need to be devised [2].

ARTISTIC

The potential of art for spatiotemporal representation needs attention. Art is well known for having the potential to affect humans at a deep level. It has shifted from being a major but decorative aspect of early maps to being largely ignored in the science-led map of the past few centuries. In the last 10 years, there has been a growing recognition that art has the power to provide an alternative representation of the world that is different in kind to maps [1], reflected in art and cartography having its own ICA commission.

Art and cartography have been linked in three ways [1]. Firstly, map-makers co-opt artistic methods and techniques into the creation of their maps (e.g. exploring the parallel of caricaturing and cartographic generalization [8]). Secondly, an artist develops their own vision in relation to the conventional map. Lastly is the notion of an "anti-map" (i.e. art) linked to a map in some way. An example of the latter is a visual art interface that uses a scanned watercolour artwork to access a time sequence of maps [16], unifying "…multiple themes, locations and times into a single cohesive image", lending narrative power that maps (and text) would find cumbersome and difficult to emulate.

Considering big data, it would seem that the use of artistic techniques for representation (i.e. a form of abstraction) would have the most potential for revealing hidden patterns. Art could be useful in the visual depiction of underlying meaning of data, as well as representing process and phenomenon. These (meaning, process, phenomena) were challenges in the 2001 agenda [4]; virtual environments have attributes that would be useful for these challenges too. The agenda also highlights multisensory interfaces as a research initiative [2], opening up sound and music.

CONCLUSIONS

Each of the three approaches presented here can potentially address specific characteristics of big data: abstracted (volume, variety, exhaustivity, relational and resolution), realistic (multidimensionality, exhaustivity, variety and multiple scales) and artistic (multiple scales, dimensions, uncertainty and variety in a single flexible representation). Further work on putting these representations into a geovisual analytics context (i.e. a dynamic solution) could be an effective way of dealing with the also dynamic 'velocity' aspect of big data. The linked representations may include a virtual environment or some that are derived from, fine art or music, rather than the conventional scientific representations - or a mix of all these types.

Agents had a prominent role in the 2001 agenda, and they would be a part of the research challenge here too, in the original contexts. Firstly to guide through the bewildering amount of representations, setting their parameters and managing possible combinations with other representations [4]. In a VE context, in-environment agent guides would help the user [2,18]. Agents also could have a role in using geocomputation to uncover structure in complex representations [5]. Cognition and Usability are important aspects and will have a central role in the testing of new representations and interfaces for big data. This is especially true given the personal bias of a huge chunk of this data (e.g. data collected by individuals, about themselves, with their own devices).

REFERENCES

1. Caquard, S and Taylor, D R F. 2005. Art, Maps and Cybercartography: Stimulating Reflexivity among Map-Users. In D Taylor. *Cybercartography.* 285-307.
2. Cartwright, W et al. 2001. Geospatial Information Visualization User Interface Issues. *CaGIS*, 28,1,45-60.
3. Chen M et al. 2013. Real geographic-scenario-based virtual social environments: integrating geography with social research. *Env. Planning B,*40, 6, 1103 – 1121.
4. Fairbairn, D et al. 2001. Representation and its relationship with cartographic visualization: a research agenda. *CaGIS*, 28, 1, 13-28.
5. Gahegan, M et al. 2001. The Integration of Geographic Visualization with Knowledge Discovery in Databases and Geocomputation. *CaGIS*, 28, 1, 29-44.
6. Gong, J and Lin, H. 2006. Collaborative Virtual Geographic Environment. S Balram and S Dragicevic *Collaborative Geographic Information Sys.,*186-207.
7. Hudson-Smith A. 2008. The Visual City. In: M Dodge et al (eds). *Geographic Visualization* 183-197.
8. Jones, C B. 1997. *Geographical Information Systems and Computer Cartography*. Routledge.
9. Kitchin, R. 2013. Big data and human geography: Opportunities, challenges and risks. *Dialogues in Human Geography*, 3, 3, 262-267.
10. Konecny, M. 2011. Cartography: Challenges and Potential in the Virtual Geographic Environments Era. *Annals of GIS*, 17, 3, 135-146.
11. Kraak, M. 2003. The Space-Time Cube Revisited from a Geovisualisation Perspective. In: *Proc. ICC* 1988-96.
12. Laube P et al (2004) Finding REMO – detecting relative motion patterns in geospatial lifelines. P Fisher (ed.) *Developments in Spatial Data Handling*, 201-215.
13. MacEachren , A M and Kraak, M-J. 2001. Research Challenges in Geovisualization. *CaGIS*, 28, 1, 3-12.
14. Meng, L. 2009. Affordance and reflex level of geovisualization. In: H Lin and M Batty (eds) *Virtual Geographic Environments*, 136-150.
15. Moore A B. and Bricker M. 2015. "Mountains of work": Spatialisation of work projects in a virtual geographic environment. *Annals of GIS*, accepted.
16. Moore, A, et al. 2011. A Visual Art Interface to an Embedded Sequence of Maps. *CaGIS,* 38, 2, 185-192.
17. Moore, A B and Rodda, J. 2015. Adaptive Relative Motion Representation of Space-Time Trajectories. *The Cartographic Journal*, accepted
18. Slocum, T A et al. 2001. Cognitive and Usability Issues in Geovisualization. *CaGIS*, 28, 1, 61-75.
19. Virrantaus, K., Fairbairn, D & Kraak, M. J. (2009). ICA Research Agenda on Cartography and GI Science. *The Cartographic Journal,* 46(2), 63-75.